in its illuminative capacity, of the central body of our system, are evidently illusory. The actual radiation of the sun would be not improbably decupled by the sudden change of its atmospheric and photospheric constitution to that of Sirius or Vega. In other words, the stock of energy now sufficing for the expenditure of ten million years would then be dissipated in one million, with a corresponding abridgment in time of the heating and lighting efficacy thus vastly heightened in intensity. The same *caveat* applies—should it be concluded that the Sirian is a later than the solar stage—to attempts to assign a term for the inevitable exhaustion of the great fountain of vital possibilities. The objection is however evaded by Prof. Langley's statement (p. 100) that, *at the present rate*, "the sun's heat-supply is enough to last for some such time as four or five million years before it sensibly fails. It is certainly remarkable," he adds, "that by the aid of our science man can look out from this 'bank and shoal of time,' where his fleeting existence is spent, not only back on the almost infinite lapse of ages past, but that he can forecast with some sort of assurance what is to happen in an almost infinitely distant future, long after the human race itself will have disappeared from its present home. But so it is, and we may say—with something like awe at the meaning to which science points—that the whole future radiation cannot last so long as ten million years."

Our author is sanguine as to the prospect of economically applying the sun's heat to mechanical purposes. "From recent measures it appears that from every square yard of the earth exposed perpendicularly to the sun's rays, in the absence of an absorbing atmosphere, there could be derived more than one-horse power, if the heat were all converted into this use, and that even on such a little area as the island of Manhattan, or that occupied by the city of London, the noontide heat is enough, could it all be utilized, to drive all the steam-engines in the world" (p. 111). No wonder that, enticed by such calculations, "practical men" should devote attention to this unfathomable source of power; and we may well believe, with Prof. Langley, "that some of the greatest changes which civilization has to bring may yet be due to such investigations."

"Future ages may see the seat of empire transferred to regions of the earth now barren and desolated under intense solar heat—countries, which for that very cause, will not improbably become the seat of mechanical and thence of political power. Whoever finds the way to make industrially useful the vast sun-power now wasted on the deserts of North Africa or the shores of the Red Sea, will effect a greater change in men's affairs than any conqueror in history has done; for he will once more people those waste places with the life that swarmed there in the best days of Carthage and of old Egypt, but under another civilization, where man shall no longer worship the sun as a god, but shall have learned to make it his servant."

In his chapter on "Meteors," our author seems to view with a certain degree of favour the suggestion that some of these small bodies "may be the product of terrestrial volcanoes in early epochs, when our planet was yet glowing sunlike with its proper heat, and the forces of Nature were more active" (p. 193). He does not, however, stop to discuss the difficulties besetting this hypothesis; had he done so, he could scarcely have failed to conclude them insuperable. The resistance opposed by the atmosphere of the earth to the upward flight of projectiles from its surface has, for instance, never been sufficiently taken into account. It is quietly assumed that some unspecified and insignificant addition to the initial velocity needed to secure definitive escape in a vacuum, would have sufficed to overcome atmospheric hindrances; whereas the minimum swiftness at starting in the second case should be at least thrice, or quadruple that in the first. The effectiveness of the air in arresting motion is practically exemplified in the continuous meteoric bombardment against which it forms our sole shield. Yet the projectiles composing it possess far higher velocities than terrestrial volcanoes could, under any conceivable circumstances, be supposed to impart. And the few among them that meet the earth's surface are impelled towards it by gravity after their own movement has been wholly, or all but wholly destroyed. Instances must be very rare in which an aerolite has brought down with it in its fall any portion of its orbital speed. Moreover, our present atmosphere is doubtless rare and shallow compared with its pristine condition; while there is no certainty that volcanic action, of an explosive kind, was ever much more energetic than it now is.

Prof. Langley adopts, or rather admits the "temperature-classification" of stellar objects current at the time when his concluding chapter on "The Stars" was written. It speaks volumes for the rapidity with which the "new astronomy" progresses that, in a few short months, this scheme—to which there were always serious objections—should have fallen obsolete. Mr. Lockyer's recent investigations have at least had the effect of rendering a complete revision of ideas on the subject indispensable. The book with which we are just now concerned professes, however, not even to describe, but barely to mention, the various departments, photometric, spectroscopic, and photographic, of stellar physical astronomy, "on each of which," the author justly remarks (p. 248), "as many books, rather than chapters, might be written, to give only what is novel and of current interest. But these," he adds, "are themselves but a part of the modern work that has overturned or modified almost every conception about the stellar universe which was familiar to the last generation, or which perhaps we were taught in our youth."

An English edition of a work which we can recommend as corresponding with singular felicity and charm to the designs of the writer, is in preparation, and will shortly appear. Some photographs of the moon, too recent to be as yet generally known, will probably replace in it such of Mr. Nasmyth's lunar illustrations as figure in the American edition.

A. M. CLERKE.

SOAPS AND CANDLES.

Soaps and Candles. Edited by James Cameron, F.I.C., Analyst in the Laboratory, Somerset House. "Churchill's Technological Hand-books." (London: J. and A. Churchill, 1888.)

THE object of this hand-book, as stated in the preface, is to add to the articles originally published in Cooley's "Cyclopædia" additional information from various scattered sources, so as to present, in as small a compass as possible, information which it is hoped may be found useful to technological students and others interested in the industries described. Compression of bulk being a main object, it is assumed that the reader has some degree of acquaintance with various points connected with theoretical and practical chemistry and certain analytical processes, so that details in such cases may be omitted without interfering seriously with the usefulness of the book. In carrying out the work of compilation, the same necessity for economizing space has rendered imperative considerable care in selecting and "boiling down" the matter, derived from some two dozen different sources in the way of English bibliography, for the most part published within the last few years; amongst which may be more particularly mentioned the works on soap-making, candle-manufacture, and allied industries by Morfit, Kurten, Dussauce, Christiani, Ott, Lant Carpenter, and Watt; and the Cantor Lectures of Field ("Solid and Liquid Illuminating Agents") and of Alder Wright ("Toilet Soaps"). References to Continental literature and patents, though comparatively infrequent, are also to be found at intervals throughout the book.

On the whole, it must be admitted that the author has carried out the work of selection and excision, compilation, abstraction, and general editing with great judgment, and that he has succeeded in getting into very small compass not only a large amount of general information, but also a valuable epitome of most, if not all, of the various advances in manufacture and the additions to scientific knowledge that have been made up to the present date in connection with the industries treated of, comprising not merely the production of soap and candles, but also the intimately associated manufacture of glycerin. This latter is quite a modern offshoot from the parent industries, neither of which, however, can claim as high an antiquity as some of the metallurgical operations; for, whilst the property of certain oils and animal fats to become converted into a saponaceous mass by treatment with the lye of wood ashes was known in the first century in an incomplete way, as evidenced by the writings of Pliny, no authentic information is extant leading to the belief that anything of the nature of true soap was known at any much earlier period; the materials referred to by the Old Testament writers as *borith*, and translated "soap" (or, in early editions, "sope"), appearing to have been simply alkaline matter, without any oil or fatty ingredient combined therewith. On the other hand, the manufacture of candles, *i.e.* a wick surrounded by a *solid* fusible matter capable of combustion under such circumstances like oil in a lamp, does not appear to have been practised among the ancients, lamps burning *fluid* oil being their usual source of artificial illumination: probably torches, or thick wicks impregnated with oil, pitch, &c., and sufficiently stiff to be handled, were the earliest form of candle. Not until the fourth century of our era, however, does this crude device appear to have developed into anything approaching the modern form of candle, wax being then used as the combustible matter in the finer kinds, and tallow or other solid animal fat in the coarser descriptions.

The researches of the yet living M. Chevreul, made in the early part of the present century, cleared up the chemical constitution of oils and fats generally, and largely helped to bring about great improvements both in the manufacture of soap and in that of candles: they demonstrated that oils and fatty matters in general are, for the most part, compounds analogous to mineral salts, being produced by the union of a "fatty acid" and an organic compound of weak basic character, *glycerin*, in the same way that a mineral acid and a strong base or metallic oxide will saturate one another to form a salt of the ordinary type; and that soaps are the alkaline salts of the fatty acids contained in the oil, &c., used, the process of "saponification" being simply the elimination of the organic basic constituent, glycerin, by the more powerful alkali employed, potash usually forming a "soft" soap, and soda a "hard" one. By treating the soaps thus formed with mineral acids, the "fatty acids" are similarly displaced from combination with the alkalies, and substances are thus obtained usually less fusible than the original fatty matter, but, like it, capable of being burnt in conjunction with a wick, and frequently with less liability to smoking and charring the wick. The leading developments of the candle industry thence resulting have accordingly been in the direction of producing the fatty acids by saponification (or cheaper processes substantially equivalent thereto), and expression of the more fluid constituents (usually, though somewhat unsystematically, termed *oleine*), so as to render the solid residue, or *stearine*, of higher melting-point, and therefore better suited to form candles not apt to bend in summer or in hot climates; and the use of mineral solid hydrocarbons (paraffin-wax and allied materials from paraffin-oil, petroleum, ozokerite, &c.) as ingredients in combination with, and sometimes to the exclusion of, the stearines thus formed. The more solid fats (tallow, suet, and certain solid vegetable fats) are naturally the substances most largely employed, as furnishing the greatest yield of solid stearine suitable for candle-making; but several oils and semi-fluid products (like palm and cocoa-nut oils), when chilled and pressed, yield a notable quantity of more solid constituents equally available for the purpose. The fluid fatty acids, or "oleines," obtained as by-products in the candle industry, are either neutralized directly by aqueous caustic alkalies, thus forming soaps, or, according to the recent process of *Radisson*, are fused with caustic alkalies (preferably, but not necessarily, potash), whereby oleic acid becomes converted into solid palmitic acid, of sufficiently high melting-point to be capable of employment for making candles.

For the manufacture of soaps, scarcely any fatty matter, whatever its source or lack of purity, comes amiss; it being of course obvious that the coarser kinds are only available for the cheapest scouring soaps, and that only the better kinds can be employed in the production of superior classes of soaps, especially those intended for toilet soaps of high quality (which term by no means applies to all in the market). Recovered greases from wool-scouring and fulling operations, fœtid animal fats from the carcasses of horses, bones, and by-products of glue-manufacture and tanning, &c., greasy matters extracted from dead cats and dogs netted in the rivers and streams, and even that obtained from the scum of sewage, represent some of the least attractive of the sources of oleaginous matter dealt with by the soap-boiler; whilst more or less damaged or rancid oils, unfit for other use, and "foots" (residues containing much impurity, which separate during the processes of refining various kinds of oils), together with the somewhat impure oily matters obtained by the aid of solvents (*e.g.* carbon disulphide) from the marcs or cakes obtained in olive and seed-oil crushing, cocoa-nut and other rank vegetable oils, and animal tallows, lards, suets, &c., imported from abroad, and obtained by treatment usually of such a nature as to render the product more or less malodorous, represent a better class of raw material, suitable, after more or less purification, for the ultimate production of the ordinary kind of household and laundry soaps. The finest varieties of lard, &c., and purified almond and other comparatively choice vegetable oils, and such like superfine materials, constitute the substances actually used in the manufacture of some of the best varieties of toilet soap, and *supposed* to be employed in the production of all such more delicate varieties.

The author briefly but clearly describes the leading processes and methods by means of which useful and even superior qualities of soaps are manufactured in bulk from the more ordinary materials, and the finer kinds from the choicest sources, usually on a smaller scale. Numerous analyses of various sorts of soaps are quoted, and the methods of production of "filled" (*i.e.* adulterated and watered) soaps, and of the composite scouring materials containing silicate of soda and analogous alkaline compounds together with true soap, are adverted to. It might, perhaps, be considered that sufficient stress has hardly been laid on the enormous extent to which such admixture is sometimes carried on in the case of certain articles still sold under the name of soap. When a scouring material contains only one-seventh of its weight of actual soap (mostly from cocoa-nut oil), and about as much silicate of soda and inert soda salts added to "harden" the mass, the balance being water pure and simple; or when a so-called "toilet soap" contains less than two-fifths of its weight of true soap, and nearly as much water, the balance being simply sugar and a more or less marked excess of corrosive alkaline matter (both calculated to act most injuriously on tender and delicate skins), it would be supposed by many that the limit of honest trading and proper description of quality has been pretty closely approached, if not a long way passed, by describing and selling such articles as "soap" at all. In the description of the manufacture of transparent toilet soaps by the process of solution of previously made soap (mostly yellow or resin soap) in alcohol, the author states that "most makers also add a certain proportion of glycerin." It would be more correct to say that in the great bulk of such soap actually sold a very considerable quantity of *sugar* is present; whilst glycerin, although frequently professedly a constituent, is usually conspicuous by its entire absence from the composition—a difference by no means to the advantage of the consumer, if troubled with a sensitive skin, although not of any great consequence to the fortunate possessor of a stout healthy epidermis not easily affected by external influences.

C. R. ALDER WRIGHT.

INDIA IN 1887.

India in 1887. By Robert Wallace, Professor of Agriculture and Rural Economy in the University of Edinburgh. With plates and illustrations. (London: Simpkin, Marshall and Co. Calcutta and Bombay: Thacker, Spink and Co., 1888.)

PROFESSOR WALLACE has evidently thrown his heart as well as his brains into his self-imposed task. He wished to know the effect of his own teaching, and that of the college to which he was attached, upon the development of Indian agriculture—and he went to see for himself. Let us hope that Prof. Wallace will have his reward for so unselfish a motive. The key to his position lies in the fact that Indian Government scholarships have been for many years bestowed at Cirencester upon Indian native graduates who have been selected for this purpose, with a view to their subsequent employment in the Agricultural and Forestry Departments of India. His object, as he himself expresses it, is "to induce the Government to alter its plans as regards the Indian Agriculture Department, and to see that ground which has been lost by inexperienced officers is yet capable of being regained by efforts made in the right direction." Quixotic as any attempt may appear to cause a Government department to alter itself, or to quietly submit to alteration, no doubt the best plan is to appeal to the public, and this is what Prof. Wallace has done. He has, no doubt, to some extent courted contradiction and hostile criticism from those already engaged in agricultural improvement in India. His book is not wanting in denunciation of the existing system, the strength of which lies in the strongly practical bias of the writer, who sympathizes with the farmer and his ways, whether found in the stalwart son of the soil in England or Scotland, or in the ryot of India. Their methods are proved methods, their opinions are the result of thousands of years of mental evolution. Prof. Wallace clearly shows an inherent dislike to that kind of innovation which springs from superficial knowledge gained in one part of the globe and thrust upon those who are engaged under totally different circumstances of soil and climate. He insists most properly, we think, that it is a delusion to imagine that any man, however able, can gain a thorough or adequate knowledge of the science and practice of agriculture in two years. Without in the least detracting from the value of two years spent in study at an agricultural college, he insists that the first step is *the study of native agricultural practices* "by men who have been trained in agriculture from their early youth in this country, and who have subsequently acquired a sound knowledge of the sciences bearing on the subject."

In the same spirit he inveighs heavily against the almost universal employment as model farm managers of men who have had no truly agricultural training, either practical or scientific, and who have no intimate knowledge of the native methods of cultivation. The result of this system has been that "many failures have destroyed the confidence of Government; and anything agricultural, that is now being done, is reduced to the merest *minimum*, with a chance any moment of being utterly abandoned."

While these views are forcibly expressed and abund-